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A Survey to Capture Needs Assessment for Graduate Teaching Assistant Training

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ABSTRACT

Graduate teaching assistants (GTAs) often teach the majority of contact hours within engineering with little pedagogical knowledge. To plan efficient professional development for GTAs to address this, we created and administered a survey to measure the perceived importance of GTAs' roles and responsibilities. GTAs, faculty, and students rated the importance of each of 24 GTA roles and responsibilities on a 5-point Likert scale and the perceived competence of GTAs on these 24 items. We used exploratory factor analysis and reliability tests to ascertain construct validity and reliability. We conceptualized the resulting four factors (which accounted for 54% of the total variance) as the following: 1) clear communication, 2) student management, 3) preparation for feedback and assessment, and 4) course management/policy knowledge. Correlations with an empirically-validated teacher motivation measure indicated the four factors were positively related to GTAs' intrinsic motivation. Comparisons among scores for GTAs, faculty, and students revealed many similarities and several significant differences among these groups, especially in ratings of competence between GTAs and others.

Key Words: Graduate Teaching Assistants; GTA Training and Development; Faculty, student, and GTA perspectives

INTRODUCTION

A widely-acknowledged factor inhibiting the learning, development, and retention of engineering students is the inexperience and lack of pedagogical education of many instructors (Moving

Forward to Improve Engineering Education 2007). These concerns about recruitment and retention of students in engineering disciplines have resulted in numerous calls for reform (Rugarcia et al. 2000; Educating the Engineer of 2020: Adapting Engineering Education to the New Century 2005; Galloway 2007). Regardless of the chosen response to such calls, it is clear that quality education requires the presence of instructors who have learned to teach effectively. Unfortunately, because we often rely on "on-the-job" training, faculty become skilled at teaching after receiving their doctoral degrees and "practicing" on students. For this reason, institutions commonly establish teaching effectiveness centers dedicated to faculty development. Moreover, and of greater concern to us, much undergraduate teaching, especially during laboratories which may constitute 50% or more of the time that students are in the classroom, is performed by Graduate Teaching Assistants (GTAs) who may receive no training in pedagogy prior to their first teaching experience (Cox et al. 2011; Shannon, Twale, and Moore 1998). Given the importance of instruction in determining students' willingness to pursue undergraduate degrees in engineering (Seymour and Hewitt 1997) and the critical role the first year laboratory can play for students making the transition from high school to college (O'Neal et al. 2007), the pedagogical knowledge and skills of GTAs becomes even more critical. Sadly, while one would predict that the inexperienced would be aware of their lack of skill and pedagogical knowledge and would seek assistance, this does not always appear to be the case. Perhaps this indicates that GTAs are performing at the expected level for their profession. Alternatively, this may indicate ignorance of expectations or lack of interest or motivation.

We conducted the research described here to ascertain, through surveys of faculty, GTAs, and students, what characteristics are considered to be most important in successful engineering GTAs and what are the perceptions of GTAs' competency levels. This study was undertaken in preparation for the development and implementation of a GTA training program, both to set the objectives of the program and to establish a baseline for measuring the impact of the program in the future. We tested psychometric properties of the measure by examining factor structure, reliabilities, and concurrent construct validity. To examine concurrent construct validity, we examined how our new survey is related to teacher motivation measure, an empirically validated measure. This paper presents the results for the reliability and validity tests, as well as the insights we gathered from administering the survey at our institution.

Additional sections of the paper include Background and Rationale, providing justification for GTA training, insights from previous research on training GTAs, and common problems faced by GTAs. The Methods section provides details on the survey participants, the components of the survey, teacher motivation measure, and procedures. The Results and Discussion sections provide results for the factor analysis and other reliability and validity tests, and an analysis of the data from the trial administration of the survey. The Conclusions, Limitations, and Future work section summarizes

the findings, lists the limitations and describes how the results may be used to develop or improve a training program for GTAs.

BACKGROUND AND RATIONALE

It is logical to think that variations within courses (i.e. across sections or semesters) can affect students and programs. When engineering courses are taught by different faculty members and graduate teaching assistants using different teaching approaches, students' course satisfaction and learning outcomes vary considerably among courses. While oversight of course content often exists, students taking the same class under different instructors often have significantly different levels of conceptual understanding and skills gained from that course. This can impact subsequent courses that require pre-requisite knowledge. Variations in teaching quality among faculty can be addressed through professional development programs that introduce instructors to the best practices and latest developments in pedagogy and course design. However, although graduate teaching assistants play an important role in engineering student learning, many higher education institutions do not have a professional development program for GTAs in place (Luft et al. 2004). Therefore, another solution to the variability in student understanding and satisfaction among sections or semesters might be to provide GTAs with the same professional development training, so labs and discussion sections are taught well and in a consistent manner. In an effort to enhance GTAs teaching effectiveness, Cox and her colleagues (Cox et al. 2011) developed an assessment tool (i.e., the Global Real-time Assessment Tool for Teaching Enhancement) to provide GTAs quantitative and qualitative feedback regarding their instructional performance from students and supervisors. In conjunction with the beneficial feedback information from various stakeholders, GTAs' reflection and perception of their instructional practices play an important role in engaging in professional development endeavors to enhance their teaching skills. While extensive GTA training and professional development programs have their merits (Bond-Robinson and Rodriques 2006; Prieto, Yamokoski, and Myers 2007), there exists the question about whether programs less costly in time or money could be sufficiently beneficial. To test this, one starting point would be with an evaluation of the expectations for GTAs and the degree to which they meet expectations without training.

As the nation tries to improve Science, Technology, Engineering, and Mathematics (STEM) education on many different fronts, work focusing on GTA training must not be overlooked. At doctoral degree granting institutions, GTAs may contribute substantially to undergraduate education (Sundberg and Armstrong 1993). Many engineering courses have large lab components predominantly taught by GTAs. For a typical 3 credit-hour engineering class at many institutions, faculty teach two 50-minute

lectures, while less experienced GTAs teach two hours of lab per week. Because GTAs interact as much with students as do faculty, training in classroom management and pedagogy for these novice instructors may have greater impact on student learning and retention than similar efforts aimed at more experienced faculty, who may be set in their ways or may already be more accomplished instructors. A training program may reduce the negative impact of having GTAs who do not consider themselves teachers, or who are not aware of their roles and responsibilities. Because GTA selections are often influenced by advisors' needs for their research programs and students seeking financial assistance for tuition, irrespective of whether they are qualified or prepared to be GTAs, teaching quality among beginning GTAs can be extremely uneven. GTAs often receive no or little systematic training (Buerkel-Rothfuss and Gray 1990; Luo, Bellows, and Grady 2000; Prieto 1999; Prieto and Altmaier 1994), and are unprepared to take on their teaching responsibilities due to lack of exposure to the best practices in teaching and classroom management (Anderson 1992; Civikly and Hidalgo 1992). At the institution under study, there exists little coordination of the selection and training of GTAs beyond requirements for international GTAs to pass an exam and receive some training on culture and communication, and safety training for all GTAs.

In science and engineering courses, there is a long history of using homework, labs, and discussion sections as a means of providing students with the opportunities to practice and assess their conceptual understandings and higher order cognitive skills. At universities with substantial graduate programs, this is the primary domain of the GTAs. Thus, GTAs become a substantial source of feedback and the primary contact for individualized instruction (Herrington and Nakhleh 2003). Laboratories provide opportunities for "hands-on" experience favored by concrete, transitional and sensory learners (Leonard 1997). While laboratories help students learn to make data-driven decisions (Pickering 1988), their primary goal in the minds of faculty is to afford students more time to learn concepts (Bond-Robinson and Rodriques 2006). The laboratory environment and the influence of the GTA on that environment have been shown to play a major role in student retention in STEM disciplines (O'Neal et al. 2007). Given the increased responsibilities of GTAs and their impact on student learning, preparing GTAs to be effective teachers is critical not only in retaining undergraduates and improving student learning and engagement, but also in retaining qualified college instructors. Many new undergraduate engineering students make decisions related to their future academic endeavors based on their perceptions of those GTAs. Moreover, the GTAs, if unprepared and untrained as teachers, will be more likely to experience frustration and failure (Allen and Rueter 1990), which may affect their own decision to leave academia.

Even with training programs, new GTAs still consider college teaching a challenge (Feezel and Myers 1997) when their pressing concerns in relation to teaching are not appropriately addressed

in the GTA training program. Thus, identifying and incorporating concerns of GTAs into the development program is a key in enhancing the effectiveness of the training programs for GTAs. Fuller (Fuller 1969) suggests that to ensure effective teacher development programs, it is critical to assess teacher concerns accurately. In addition, teacher training or professional development programs that do not reflect the needs and interests of participants are unlikely to motivate them, which in turn can result in the failure to attain the program's educational goals and objectives (Cho et al. 2011). This speaks directly to the importance of needs assessment surveys designed to identify what motivates and concerns teachers in advance of developing training programs. The present study focuses on developing a GTA needs assessment survey and investigating its psychometric properties to provide empirical evidence that the survey is a valid and reliable tool that can be used to capture areas for GTA training.

Given that the primary goal of designing and administering GTA training is to enhance teaching efficacy and effectiveness, literature on teacher efficacy guided us to define areas for teaching improvement that need to be the potential focus of GTA training. Previous research has conceptualized three primary domains of teaching in which efficacious teachers tend to demonstrate excellence (Klassen et al. 2009; Tschannen-Moran and Hoy 2001). The three domains include 1) student engagement (i.e., capabilities to motivate and engage students to learn), 2) instructional strategies (i.e., capabilities to employ a variety of appropriate instructional and assessment strategies), and 3) classroom management (i.e., to manage student behaviors and classroom discipline). Based on these domains of teaching excellence, we developed survey items to assess the degree to which GTAs place a value on and feel competent and prepared to perform successfully.

To further examine the construct validity of the new measure, we examined how GTAs' motivation to teach is related to their responses on the survey measure. We expected that the extent to which GTAs are motivated in a self-determined manner will be associated with their perception regarding the importance of GTA roles and responsibilities. Deci and Ryan (2000) discussed that different types of self-determined motivation can be assessed on a continuum ranging from intrinsic to identified to introjected to extrinsic to amotivation. Intrinsic motivation represent the highest level of self-determination while amotivation represents the lowest level of self-determination. People with intrinsic motivation engage in a task because of their interest in or enjoyment of the task whereas those with identified motivation engage in a task because of the value and importance of the task. People with introjected motivation tend to engage in a task because of internal pressure and responsibilities whereas those with extrinsic motivation engage in a task because of external forces, such as monetary rewards or external pressure. Amotivation denotes no willingness to engage in a task.

METHOD

Participants

The study was conducted at a land-grant institution located in the Midwest. Invitations to participate in the online survey were sent out via email to all engineering graduate students (N = 900) at the institution. Email lists were provided by the Office of Institutional Research, and invitations were sent so that the identity of each invitee was kept anonymous. We were interested in capturing the views of all graduate students (GTAs or not) in this project. However, for this study we used a subset of the participants who either currently work as GTAs or have done so in the past. Out of a total of 216 students who responded to the survey, 144 students met the above criteria. Of the 144 graduate teaching assistants, 85.6% were male, 10.0% were female, and 4.4% did not report. Furthermore, 66.3% were master's degree students and 33.7% were doctoral students. Although the proportion of female participants in our sample is significantly smaller than that of male participants, it actually represents the male/female ratio (81.5% male students, 18.5% female students) in the engineering student population of the participating institution. Of the respondents, 60% had an undergraduate degree from a non-US institution. The GTAs spanned the entire teaching experience range of teaching assistants, from those who were first time GTAs to those who had taught up to 12 semesters. All results provided below are for these 144 survey respondents.

Invitations for research participation were also sent out to all the faculty and the undergraduate students in the college of engineering. A total of 38 (out of about 100) faculty and 365 (out of about 2000) undergraduate students responded to our survey. Demographic information was not collected from these groups, as it was not deemed necessary. Email lists for these groups were also provided by the Office of Institutional Research, and invitations were sent so that the identity of each invitee was kept anonymous.

Procedure

The survey was administered using SurveyMonkey (www.surveymonkey.com) and consisted of six sections: information required for informed consent, Needs Assessment Survey Importance Ratings (24 items), Needs Assessment Survey Competence Ratings (24 items), Teacher Motivation Survey (15 items), demographic data regarding personal characteristics and career plans (10 items), and demographic data regarding employment specifics (10 items). Participants could skip any section or question. We offered participants the opportunity to add comments at the end of each opinion section. Faculty and undergraduate students were asked to complete two sections (Need Assessment Survey Importance Ratings and Competence Ratings), while GTAs were asked to complete all six sections.

Measure

Needs Assessment Survey

We developed a needs assessment survey to capture to what extent GTAs rate the importance of typical GTA roles and responsibilities such as providing feedback to students, grading student work in a fair and consistent way, and establishing a working relationship with students, etc. All roles and responsibilities chosen are provided in Table 1 of the results. The survey items were drawn from the literature or created by the authors as explained in the previous section. The instrument was developed to incorporate the following features:

- Relevant and applicable in GTA training settings
- Inclusive and comprehensive to capture GTAs' perceptions and needs for professional development in higher education settings
- Multi-dimensional (e.g., instructional practices, classroom management, engagement with students)

The participants were asked to rate the importance they placed on each of 24 GTA roles and responsibilities on a 5-point Likert scale with 1 representing 'Not at all important' and 5 representing 'Critically important' on the roles and responsibilities questionnaire. All three groups (GTAs, faculty and students) rated all the items on the same scale. A 5-point Likert scale was also used for competence ratings for the 24 items with 1 representing 'Not at all competent' and 5 representing 'Very competent.'

Analysis of the data included exploratory factor analysis and reliability tests to ascertain the validity and reliability of the survey using SPSS. Exploratory factor analysis was conducted with oblimin rotation with the 24 perceived importance items of GTA roles. We used the eigenvalue-greater-than-one rule (Kaiser and Rice 1974) and scree test (Cattell 1966), to determine the number of factors that would represent appropriately the perceived importance of GTA roles and responsibilities. Eigenvalues indicate the total variance accounted by each factor and factors with eigenvalues equal or higher than 1 were retained. The scree test creates a plot of the eigenvalues by ordering each factor by variance and factors above elbow points in the plot (i.e. where sudden decrease in variance is observed) were retained.

Motivation to Teach

The Work Tasks Motivation Scale for Teachers (WTMST) (Fernet et al. 2008) was used for this study. The WTMST was designed to assess five constructs in motivation toward six different aspects of teachers' work tasks: class preparation, teaching, evaluation of students, class management, and administrative tasks. We made minor modifications of the original survey items to assess GTAs' motivation to teach. The original scale include five subscales: 1) Intrinsic motivation,

2) Identified motivation, 3) Introjected motivation, 4) Extrinsic motivation, and 5) Amotivation. We chose this measure to further examine the construct validity of GTA needs assessment survey because it is one of the empirically validated measures of teaching beliefs. Each item starts with a STEM question, "Why do you teach?" Sample response items included "Because I find teaching interesting to do" for intrinsic motivation, "Because it is important for me to carry out this task" for identified motivation, "Because I would feel guilty not doing it" for introjected motivation, "Because the school obliges me to do it" for extrinsic motivation, and "Because I don't know, sometimes I don't see its purpose" for amotivation. Participants chose the rating that most closely corresponded to their reasons for teaching (Strongly disagree, Somewhat disagree, Neutral, Somewhat agree, and Strongly agree). We conducted an exploratory factor analysis to evaluate the construct validity of the modified version of the WTMST using GTAs' self-report data. The result revealed a clear five-factor structure comprising intrinsic motivation, extrinsic motivation, and amotivation. The five factors accounted for 73% of the total variance and showed acceptable reliability coefficients (α = .79 for intrinsic motivation, α = .67 for identified motivation, α = .79 for introjected motivation α = .66 for extrinsic motivation, α = .89 for amotivation). We used the WTMST to evaluate the concurrent validity of our Needs Assessment Survey using SPSS to calculate and then to examine correlations between the factors identified in the factor analysis and the teacher motivation measure.

RESULTS

The results section is divided into two subsections. We first present the results on the reliability and validity analysis of the survey, including comparison with the WTMST. In the next subsection we present an example of what can be learned from administering the survey, i.e. the results on discrepancies between the importance and competence ratings by the three participant groups (GTAs, students, and faculty). The study on reliability and validity was presented at the 2011 ASEE National Conference (Sohoni, French, and Cho 2011). A study on the discrepancies was presented at the 2010 ASEE Midwest Section meeting (Cho, Sohoni, and French 2010), for a pilot sample. The pilot study did not ask for any demographic information, nor did it require GTAs to fill out the WTMST. While the number of participants in all three groups were lower than those in the study presented here, the results are consistent. In particular, the comparison of GTA ratings of competence with the students' and faculty's rating of GTA confidence showed the same trend in both studies. The results reported below are based on the data we collected for the follow-up study.

	Factor			
	1	2	3	4
IMP13: Effectively communicating with students	.81			
IMP14: Explaining contents clearly	.77			
IMP11: Being familiar with the course materials	.63			
IMP6: Engaging the students with the learning material	.62			
IMP8: Offering feedback on work to the students	.55			
IMP15: Overcoming cultural and language conflicts	.50			
IMP22: Maintaining authority over dominating and aggressive students		.72		
IMP17: Motivating inattentive/uninterested students		.70		
IMP24: Managing students' disruptive classroom behavior		.67		
IMP23: Avoiding offending a student while trying to simplify a concept		.65		
IMP16: Speaking to the class publicly		.64		
IMP21: Facilitating positive team dynamics and discussions		.57		
IMP19: Knowing what is expected of the TA			.65	
IMP12: Grading student work in a fair and consistent way			.57	
IMP18: Knowing answers to student questions (course content)			.57	
IMP20: Getting students to think for themselves & learn to solve problems			.55	
IMP10: Treating students with compassion and respect			.42	
IMP2: Being familiar with the syllabus				.68
IMP3: Being familiar with course objectives				.65
IMP7: Making your grading rubric available to the students				.59
IMP4: Preventing academic dishonesty				.51
IMP5: Dressing appropriately				.49
IMP9: Holding regular office hours				.36
IMP1: Establishing working relationship with students				.34
Eigenvalue	8.39	1.97	1.40	1.22
% of Variance Explained	34.95	8.22	5.79	5.07
Total Variance Explained			54.03%	

Note. Factor1=Clear Communication, Factor2=Student Management, Factor3=Preparation for Feedback and Assessment, Factor4=Course Management/Policy Knowledge, IMP=Importance

Table 1: Factor Loadings for Needs Assessment Survey for GTA Training.

Study of Validity and Reliability

To assess the construct validity of the measure, an exploratory factor analysis was performed using the principal component analysis. Results yielded four factors with eigenvalues greater than 1, accounting for 54% of the total variance (see Table 1). The scree test further suggested four factors that accounted for 35%, 8%, 6%, and 5% of the variance, respectively. Most survey items showed

	Importance		Reliability
	M	*SD*	Alpha
1. Clear Communication	4.35	.55	.81
2. Student Management	3.84	.76	.82
3. Preparation for Feedback and Assessment	4.42	.54	.77
4. Course Management/Policy Knowledge	4.05	.59	.77

Table 2: Means, Standard Deviations, and Reliabilities of Four Factors.

factor loadings greater than 0.40 except two items with a loading of 0.36 and 0.34, respectively and the cross-loadings were not substantial (all were less than 0.30). The first factor consisted of 6 items, reflecting GTAs' perceived importance of their ability to effectively communicate with students and explain course contents clearly, and thus was named 'Clear Communication.' The second factor comprised 5 items reflecting GTAs' role to deal with student behaviors and classroom disruption issues as well as to engage and motivate inattentive/uninterested students, and thus was named 'Student Management.' The third factor contained 5 items that capture GTAs' role to prepare themselves for feedback and assessment. The last factor comprised 7 items that tap into GTAs' responsibilities to become familiar with the course objectives and syllabus and holding office hours, so we named it 'Course Management/Policy Knowledge.' Survey items and factor loadings are provided in Table 1.

The data provided favourable evidence for internal consistency of the measure. The Chronbach alpha reliability coefficients with the sample of this study for the four factors was 0.81 (Clear Communication), 0.82 (Student Management), 0.77 (Preparation for Feedback and Assessment), and 0.77 (Course Management/Policy Knowledge).

Table 2 shows descriptive statistics (means, standard deviations, and reliabilities) of the four factors. GTAs placed higher importance on the factors of 'Clear Communication' and 'Preparation for Feedback and Assessment' than the other two factors.

We evaluated the concurrent validity of the measure by examining correlations between the four factors and teacher motivation measure which has been empirically validated in the literature. The results revealed that the four factors were positively correlated with GTAs' intrinsic motivation to teach (r =.18~.32) and identified motivation (r =.28~.34), while they showed little or no relations with introjected motivation (r =.03~.18), extrinsic motivation or amotivation (see Table 3).

Results for Importance and Competence Comparisons

The second purpose of our study was to capture varying perspectives and needs about engineering GTA training from different groups involved in engineering education (i.e., GTAs, faculty, and

	1	2	3	4	5	6	7
1. Clear Communication	__						
2. Student Management	.53**	__					
3. Preparation for Feedback and Assessment	.66**	.60**	__				
4. Course Management/Policy Knowledge	.66**	.52**	.58**	__			
5. Intrinsic Motivation To Teach	.22**	.32**	.18*	.23**	__		
6. Identified Motivation to Teach	.30**	.34**	.29**	.28**	.65**	__	
7. Introjected Motivation to Teach	.03	.18*	.03	.04	.07	.20*	__
6. Extrinsic Motivation To Teach	–.02	–.04	.01	.04	–.15		
7. Amotivation	–.05	.01	-.09	.05	–.17*	.47**	

*$p < .05$, **$p < .01$

Table 3: Correlations between Factors Extracted from Needs Assessment Survey and Teacher Motivation.

students). We asked all participants to rate the GTAs' competence and importance of GTA roles on each of the 24 survey items. Mean scores were calculated for each of the four categories that emerged from the factor analysis.

Difference among Groups in Importance Ratings

Table 4 shows the overall comparison of the average ratings for the four categories by the three groups on importance and competence. A multivariate analysis of variance (MANOVA) revealed significant differences among the three groups' competence and importance ratings ($F = 7.23$, $p < .001$).

On the importance ratings, subsequent univariate analysis of variance (ANOVA) indicated overall significant differences among the three groups in all categories ($F = 4.31$, $p < .05$ for 'Clear Communication'; $F = 15.19$, $p < .001$ for 'Student Management'; $F = 15.04$, $p < .001$ for 'Course Management/Policy Knowledge'), except 'Preparation for Feedback and Assessment' (see Table 4). To further examine which specific groups differed, post-hoc tests (i.e., pairwise comparisons) were performed. Students (M=4.45, SD=.44) rated significantly higher on 'Clear Communication' than GTAs (M = 4.28, SD = .55) and faculty (M = 4.20, SD = .57) did. There was no significant difference between GTAs and faculty in this category. GTAs (M = 3.84, SD = .75) placed significantly higher importance on 'Student Management' than students (M = 3.43, SD = .79) and faculty (M = 3.40, SD = .74) did. As figure 1 indicates, the same pattern was observed for 'Course Management/Policy Knowledge', with GTAs (M = 4.05, SD = .59) rating higher than students (M = 3.7, SD = .57) and faculty (M = 3.88, SD = .57).

	Importance				Competence			
	GTAs	Students	Faculty	*F*-test	GTAs	Students	Faculty	*F*-test
F1	4.28 (.55)	4.45 (.44)	4.21 (.57)	4.31*	3.79 (.74)	3.47 (.81)	3.31 (.68)	11.66**
F2	3.84 (.75)	3.43 (.79)	3.40 (.74)	15.19**	3.57 (.79)	3.42 (.75)	3.12 (.56)	6.39**
F3	4.42 (.54)	4.37 (.44)	4.27 (.59)	1.40	3.92 (.73)	3.72 (.74)	3.50 (.67)	7.31**
F4	4.05 (.59)	3.73 (.58)	3.88 (.57)	15.04**	3.85 (.67)	3.63 (.64)	3.56 (.59)	7.05**

Note. *$p < .05$, **$p < .01$; Factor1=Clear Communication, Factor2 = Student Management, Factor3 = Preparation for Feedback and Assessment, Factor4 = Course Management/Policy Knowledge.

Table 4. Difference among Groups in Importance and Competence Ratings: Means and Standard Deviations.

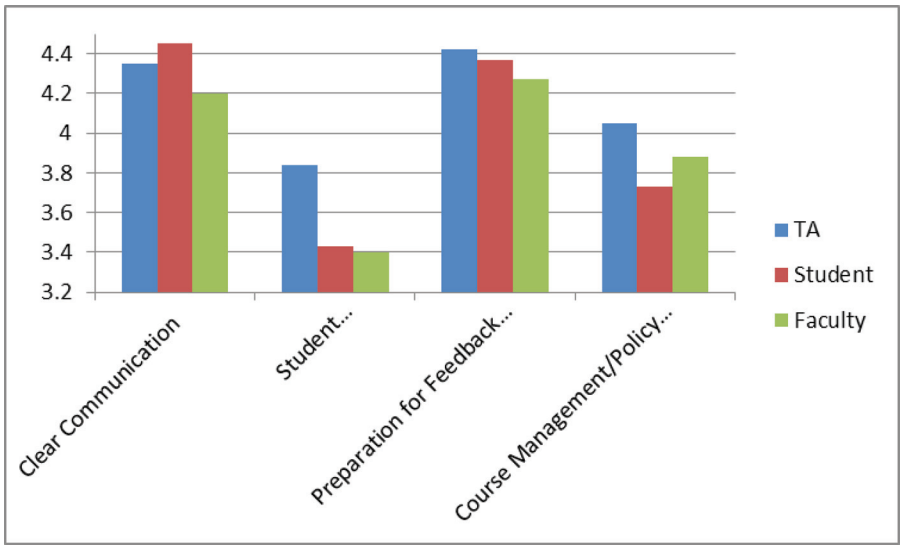

Figure 1. Consistent distributions of Importance average ratings by Groups (GTA, Student, and Faculty) for the four categories.

In terms of the distribution of importance average ratings for the four categories, we found consistent patterns across the three groups. 'Clear Communication' and 'Preparation for Feedback and Assessment' were perceived as being relatively more important than the other two categories, 'Student Management' and 'Course Management/Policy Knowledge' (Figure 1).

Difference among Groups in Competence Ratings

On the competence ratings, subsequent univariate analysis of variance (ANOVA) indicated overall significant differences ($F = 11.66$, $p < .001$ for 'Clear Communication'; $F = 6.39$, $p < .01$ for 'Student

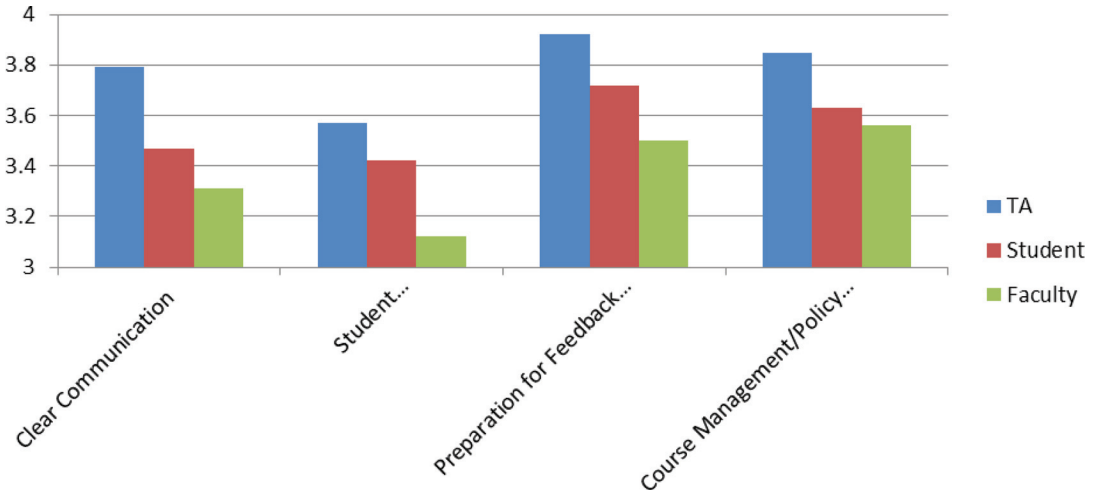

Figure 2. Difference among Groups (GTA, Student, and Faculty) in Competence Ratings.

Management'; $F = 7.31$, $p < .01$ for 'Preparation for Feedback and Assessment'; $F = 7.05$, $p < .01$ for 'Course Management/Policy Knowledge') among the groups in all categories (Table 4). Post-hoc tests (i.e., pairwise comparisons) revealed that the significant differences occurred between GTAs and the other two groups. This pattern was consistent across the categories. Faculty and students rated GTA competence significantly lower than the GTAs did (Figure 2).

In terms of the distribution of competence average ratings for the four categories, all participants consistently perceived that GTAs are less competent in 'Clear Communication' and 'Student Management' than they are in the other two categories ('Preparation for Feedback and Assessment' and 'Course Management/Policy Knowledge').

Discrepancies between Importance and Competence Ratings

We attempted to identify important but under-prepared GTA roles and responsibilities. We examined the degree to which each group showed discrepancies between importance and competence ratings. A paired-t test revealed that GTAs showed significant discrepancies between importance and competence ratings in all categories (Table 5). Students and faculty reported significant discrepancies in the 'Clear Communication' and 'Preparation for Feedback and Assessment,' while both groups did not show significant discrepancies in the 'Student Management.' We found that two categories, 'Clear Communication' and 'Preparation for Feedback and Assessment,' were consistently perceived as being more important but less prepared GTA roles by all three groups.

	GTAs				Students				Faculty			
	IMP	COM	D	t-test	IMP	COM	D	t-test	IMP	COM	D	t-test
F1	4.28	3.79	.49	10.84**	4.45	3.47	.98	14.64**	4.21	3.31	.90	7.77**
F2	3.84	3.57	.27	5.01**	3.43	3.42	.01	.29	3.40	3.12	.28	1.92
F3	4.42	3.92	.50	9.91**	4.37	3.72	.65	11.15**	4.27	3.50	.77	7.08**
F4	4.05	3.85	.20	4.76**	3.73	3.63	.10	1.81	3.88	3.56	.32	2.78**

Note. *$p < .05$, **$p < .01$; IMP=Importance, COM = Competence, D = Discrepancy; Factor1 = Clear Communication, Factor2 = Student Management, Factor3 = Preparation for Feedback and Assessment, Factor4 = Course Management/ Policy Knowledge

Table 5. Discrepancies between Importance and Competence Ratings.

DISCUSSION

Survey validity

We developed a needs assessment survey to measure GTAs' perceived importance of various roles and responsibilities. Our results provide strong evidence that it is a valid and reliable measure. Based on the four-factor structure that an exploratory factor analysis indicated, we conceptualized four categories of GTA roles and responsibilities; 1) clear communication, 2) student management, 3) preparation for feedback and assessment, and 4) course management /policy knowledge.

The findings of the current study have theoretical and practical implications for GTA training. Theoretical implication is that GTAs' roles and responsibilities are complex in nature and thus it is important to take multi-dimensional aspects of GTA roles into consideration in the measure of their needs for professional development. As shown in Table 2, GTAs placed different levels of importance on each category. GTAs tend to perceive managing and dealing with student behaviors and motivation problems ('Student Management' category) as the area of least importance. This would be consistent with an expectation that such problems should not exist among students enrolled in an engineering discipline or in college generally, especially among the second-year or later students that most GTAs teach. In addition, GTAs may not be inclined to help those they perceive as less motivated or properly engaged succeed, instead thinking that if the students don't take responsibility they should not be pursuing a degree in engineering. If so, this may reflect the GTAs perception of themselves as motivated and interested.

In contrast, GTAs felt highly responsible in areas such as being prepared to perform their primary roles such as grading student work and providing useful feedback ('Preparation for Feedback and Assessment' category), and having an ability to effectively communicate with students to facilitate better learning ('Clear Communication'). These factors may reflect the GTAs experiences as well. They may

have received criticism for deficiencies in these areas or be critical of those that taught them and may differ in how they attribute differences in the quality of instruction to specific knowledge, habits, or skills. Providing useful feedback and consistent grading are very desirable characteristics of teachers. Herrington and Nakhleh (Herrington and Nakhleh 2003) found that when asked to rank GTA characteristics, GTAs and students considered GTA knowledge and skills more important than GTA attitudes toward students, with students ranking consistency in grading higher than GTAs did. Herrington and Nakhleh also found that GTAs and students ranked the GTAs' role in motivating students low.

These results are in direct contrast to the motivation behind GTA training discussed in the Background and Rationale section. This clearly indicates that anyone who wants to develop a training program for the GTAs sampled here must emphasize the role that GTAs play in student development. The training should not only convey that GTAs are responsible for engaging and motivating students, but also provide sound pedagogical tips and exercises on how to engage and motivate students.

Furthermore, correlation analysis yielded evidence for concurrent validity. We found that GTAs' ratings of importance had a positive relationship with intrinsic and identified motivation to teach, suggesting that GTAs who enjoy and value what they are doing are highly likely to take more responsibilities in all categories of GTA roles. The positive links between these variables provides not only further evidence of construct validity of the needs assessment survey but also provides strong rationale for addressing the four categories of GTA roles in teaching workshops to promote intrinsic interest and value of teaching.

Importance and Competence Comparisons

In addition to examining the psychometric properties of the survey, we aimed to provide useful information that the survey could provide in the design and development of GTA training program. We found significant differences in importance and competence ratings among GTAs, faculty, and students. The information allowed us to capture diverse needs, viewpoints, and perspectives about GTA preparedness from different groups involved in engineering education and to incorporate them into the development of GTA training program.

One of the intriguing findings was that GTAs' self-perception about their capabilities to perform teaching activities was positive and optimistic. Although positive beliefs in their competence is motivationally encouraging (Bandura 1997), inflated estimation of their ability may interfere with them expending more effort to develop their teaching competence. This concern is supported by the low ratings of faculty and students about GTA competence.

Furthermore, the result from the current study that faculty and students tend to consider GTAs significantly less competent than GTAs consider themselves presents us with a challenge. Faculty often remain distant from the laboratories that the GTAs teach and therefore do not provide the guidance

the GTAs needs or desire (Dotger 2010). Thus faculty are not contributing to the development of the GTAs and helping to narrow this gap. We wonder whether presented with these data, faculty will come to the realization and take personal action or will they remain distant and suggest that others (e.g. lab coordinators, teaching and learning centers) be required to take more action. Alternatively, for those faculty who think that teaching ability is an intrinsic trait (Svinicki 2004), we would predict no interest or support for programs to help GTAs develop skills. The survey results would help develop a strategy for using this information to inform GTAs of the gap and encourage appropriate reflection on their part so as to motivate them toward mastery learning. This also provides us with a baseline against which to measure changes after the intervention of a GTA training program.

Unlike the competence ratings, we found similar patterns in the distribution of responses regarding the importance ratings although there were significant mean differences among the groups. All participants including GTAs, faculty and students perceived 'Clear Communication' and 'Preparation for Feedback and Assessment' as more important GTA roles and responsibilities than 'Student Management' and 'Course Management/Policy Knowledge.'

Combined with this finding, the results on discrepancies between the importance and competence ratings by the three participant groups offers more specific examples of how the survey results can be used in developing a GTA training program. The discrepancy scores between importance and competence ratings can be used to identify the primary focus of GTA training. In the present study, particularly two categories of GTA roles were consistently identified across different groups as training areas that require more attention. While GTAs' ability to communicate clearly and the extent to which they are prepared to provide adequate feedback and assessment were commonly considered more important by GTAs, faculty and students, we found that GTAs were not perceived as adequately skilled or prepared for these areas. Our data provided evidence for the utility value of using our needs assessment survey for identifying important but under-prepared GTA roles/responsibilities.

The survey enables the training to be scaled with regards to time and resources available based on the results. For example, for the set of results presented here, if one had very limited resources, they would cover only the two factors: 'Clear Communication' and 'Preparation for Feedback and Assessment.' However, if resources were available, all four factors deserve attention due to the competency discrepancy. Thus, the survey provides a basis for prioritizing the topics to be covered.

CONCLUSIONS, LIMITATIONS, AND FUTURE WORK

We conducted the research described in this paper to ascertain, through surveys of faculty, GTAs, and students, what characteristics are considered to be most important in successful engineering

GTAs and the perceptions of GTAs' competency levels. This study was undertaken in preparation for the development and implementation of a GTA training program, both to set the objectives of the program and to establish a baseline for measuring the impact of the program in the future. We tested psychometric properties of the measure by examining factor structure, reliabilities and concurrent construct validity. To examine concurrent construct validity, we examined how our new survey is related to teacher motivation measure, an empirically validated measure. Based on our results, we conclude that the survey showed favorable psychometric properties and offered beneficial information for the development of TA training program at our institution. Other notable findings include the following:

- There are 4 clear factors based on the importance ratings: Clear Communication, Student Management, Preparation for Feedback and Assessment, and Course Management/Policy Knowledge.
- In terms of the distribution of importance average ratings for the four categories, we found consistent patterns across the three groups. 'Clear Communication' and 'Preparation for Feedback and Assessment' were perceived as being relatively more important than the other two categories, 'Student Management' and 'Course Management/Policy Knowledge.'
- Post-hoc tests (i.e., pairwise comparisons) for competence ratings revealed that significant differences occurred between GTAs and the other two groups. This pattern was consistent across the categories. Faculty and students rated GTA competence significantly lower than the GTAs did.
- In terms of the distribution of competence average ratings for the four categories, all participants consistently perceived that GTAs are less competent in 'Clear Communication' and 'Student Management' than they are in the other two categories ('Preparation for Feedback and Assessment' and 'Course Management/Policy Knowledge').

Although the survey showed favorable psychometric properties, further testing is warranted to confirm that the new measure of GTA's needs assessment can be used as a reliable and valid tool across institutions. One of the limitations of the study was the low number of female respondents among the GTAs, and an overall low number of respondents among the faculty.

The survey allows various interest groups to customize their own program of training based on the survey responses. Appropriately customized GTA training helps maximize its effectiveness and increases the impact on GTAs' professional development. It is thus hoped that other institutions adopt the survey to guide their GTA training efforts.

The survey used (GTA version) is available at http://www.surveymonkey.com/s/TA. Surveys for faculty and students are at http://www.surveymonkey.com/s/faculty-survey and http://www.surveymonkey.com/s/students-survey respectively. Faculty that wish to adapt the survey for their institutions are encouraged to contact the authors of this paper.

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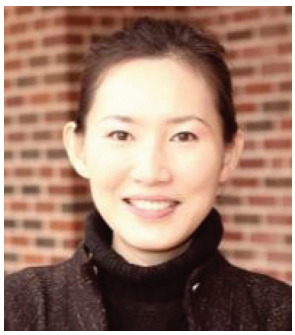

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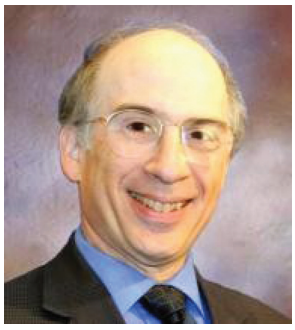

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